Modified AODV Routing Protocol Using Artificial Swarm Intelligence Technique in VANET Communications

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Abstract—Two types of ad hoc networks in mobile communications are mainly existing; one is Mobile Ad Hoc Network (MANET) and another one Vehicular Ad Hoc Network (VANET). Vehicular Ad Hoc Network (VANET) is highly demanded wireless ad hoc network. It is based on IEEE 802.11 wireless standard, which facilitates vehicle to vehicle and vehicle to roadside communications through air interface. Federal Communications Commission (FCC) suggests for VANET frequency spectrum (bandwidth) of 75 MHz in the range of 5.850 GHz to 5.925 GHz. In this bandwidth seven channels are fragmented, having each 10 MHz bandwidth, in which six channels are used for services and one channel is used for control purpose like broadcast services, e.g., safety message, announcement, etc. Communicating techniques from one vehicle (source) to another vehicle (destination) through different vehicles (nodes) is called routing. Different routing protocols for communicating information in voice, message, data, etc. from one vehicle (node) to another vehicle are applied. Also intelligent vehicular ad hoc networks (InVANETs) use WiFi IEEE 802.11 and WiMAX IEEE 802.16 for fastest communication between vehicles with dynamic mobility. In this paper we propose Modified Ad Hoc on Demand Distance Vector (M-AODV) routing algorithm. In proposed M-AODV routing protocol for ad hoc mobile networks are advanced by artificial swarm (ant colonies) intelligence technique. Modified AODV protocol is used for both unicast and multicast routing. We also discuss the importance of this Modified AODV routing protocol over all other existing routing protocols in VANET communications.

Index Terms—AODV, CSMA/CA, DSRC, MAC layer, Modified AODV (M-AODV) Routing Protocol, Artificial Swarm Intelligence, VANET.

I. INTRODUCTION

Vehicular Ad Hoc Networks (VANETs) is an emerging technology in the class of Mobile Ad Hoc Networks (MANETs). VANETs are distributed; self-organizing communication networks built up by moving vehicles, and it is classified by very high node mobility with limited degrees of freedom in the mobility patterns. Hence ad hoc routing protocols are adhered continuously to these unreliable and unethical conditions, in the event of growing effort which are identified to vehicular networks. One of the situations when evaluating routing protocols for VANETs is the application of mobility models that adapt as practically as possible to the real behavior of vehicular traffic. Apart from this, using simple random-pattern, the graphs constrained mobility models is a common practice among researchers working on VANETs. Such models may not describe vehicular mobility in a realistic way, since they ignore the peculiar aspects of vehicular traffic, such as cars acceleration and retardation in presence of nearby vehicles, queuing at roads intersections, traffic bursts caused by traffic lights and traffic congestion or traffic jams, etc. All these situations greatly affect the network performance, since they act on network connectivity and this makes vehicular movement specific to fundamental performance evaluations at the time of studying routing protocols for VANETs.

Wireless technologies [1]-[6] are extended to ad hoc networks like Mobile Ad Hoc Network (MANET) and Vehicular Ad Hoc Network (VANET) [2]-[4], [7]-[15]. Ad hoc networks are one type of network that offers communications within a certain range of areas; even connect to wide areas via basic mobile network and Internet. This study is the modest approach towards the justification for application of Modified AODV routing protocol for MANET in Vehicular Transmission, i.e., VANET communications.

VANET is one special type or a subset of MANET, which is exhaustively communicating in a group of moving vehicles or extending to a wide zone through basic mobile infrastructures or services and Internet facility. Mobile ad hoc networks, also known as short-lived networks, are autonomous systems of mobile nodes forming network either in the absence of any centralized support or presence of a basic network. The basic mobile communications is a costlier one which cannot afford communications covering all regions in the world, especially in remote and less dense populated area, wide sea or desert, etc.

In the areas where the normal mobile communications are not economically viable, ad hoc network is the best solution. MANET and VANET are self forming networks, i.e., they can work without any centralized control like Base Station (BTS) or Switch (BSC, MSC) in mobile network or Access Point (AP) in local area network (LAN) [1]-[6]. BTS is a Base Trans-receiver Station from where air interface link is connected to a mobile subscriber or instrument (MS). BSC is a Base Switching Center and MSC is a Main or Mobile Switching Center. In centralized control mobile network, a mobile path is connected from BTS to MSC via BSC or vice
versa through optical fiber or microwave link, and call connection is controlled by MSC only.

Each terminal or node (either mobile phone or computer) in a MANET or a VANET acts both as a data or voice terminal and a router or switch. A node in a cell communicates with other nodes in its transmitting range through wireless medium only. Thus a VANET is a small structure or subset of a MANET. In a VANET, certain number of moving vehicles in a small region constitutes a cell. It means that the range of wireless signal, i.e., transmitting zone from a moving vehicle is within a limited area. A vehicle, called a node, can do transmitting, receiving, and routing (connecting) to other nodes without help of any switch like Base Station (BTS) in basic mobile network or Access Point (AP) in LAN. Also the moving vehicle in a VANET cell can be connected to other nodes in another cell or other network like basic mobile network, Internet, etc. Thus total connectivity in a VANET is assured. VANETs are also known under different name like Dedicated Short Range Communications (DSRC), Inter Vehicle Communications (IVC), etc. Number of projects have been launched for VANET, e.g., FleaNet in USA, FleetNet in Germany, ITS in Japan, etc. [1]-[7], [11]-[15].

The motivation of a VANET project is to create a new algorithm or protocol or modify the existing one for use in vehicular environment. Thus VANET helps the drivers of vehicles to communicate the information in form of voice, data, image, multimedia, etc. Also it ensures safe journey by minimizing road accidents, diverting or instructing the vehicle’s direction in less populated roads avoiding traffic jam, etc. Vehicles in a VANET are having high degree of mobility, i.e., the vehicles are moving very fast, especially in high ways. As a result the two vehicles are in a direct communication range staying about one minute time only, i.e., two vehicles remain in one cell about one minute time when they are moving parallel direction or even less than one minute when they are in opposite direction [2]-[15]. For this, VANET cell configuration and number of nodes present and using as intermediate node in a particular cell by suitable routing technique is changing in nature.

VANET is based on IEEE 802.11 wireless standard which is mainly framed for WLAN, WiFi, MANET and VANET. Demerits of IEEE 802.11 standards are that no retransmission is possible for failed broadcast transmissions and that the contention window (CW) size fails to change because of the lack of MAC (Medium Access Control) level recovery. Therefore, CW is held constant for broadcast transmission. It is noteworthy mentioned that the probability of reception of a broadcast message decreases as the distance from the sender increases and under saturated conditions the probability of reception of a message is very low.

II. ARCHITECTURE OF MANET AND VANET

Initially IEEE 802.11 is implemented on WLAN at a speed of 1 or 2 Mbps (very slow) in 1997 A.D. Then IEEE 802.11 protocol family is upgraded to different versions. 802.11a uses Orthogonal Frequency Division Multiplexing (OFDM) modulation to deliver up to 54 Mbps in the wider frequency 5 GHz ISM band. IEEE 802.11b applies High Rate Direct Sequence Spread Spectrum (HR-DSSS) to achieve 11 Mbps in 2.4 GHz ISM band. IEEE 802.11g implements OFDM modulation, but operates narrow 2.4 GHz ISM band. The Federal Communications Commission (FCC) suggests for VANET frequency spectrum (bandwidth) of 75 MHz in the range of 5.850 GHz to 5.925 GHz in USA. Seven channels are fragmented, having each 10 MHz bandwidth. Out of these, six channels are used for services and one channel is used for control purpose like broadcast services, e.g., safety message, announcement, etc.

IEEE 802.11 protocols apply Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) with acknowledgements for reliable communications and avoiding collision among packets. In a VANET, Medium Access Control (MAC) layer determines a contention based access protocol, termed Distributed Coordination Function (DCF). Actually, MAC sub layer determines how the channel is allocated, i.e., whose turn to transmit next. Above MAC, there is Logic Link Control (LLC) layer to hide the difference amongst different IEEE 802 variants. The main drawback of the DCF is hidden terminal problem, hence Quality of Service (QoS) is not guaranteed in wireless network like VANET.

This hidden terminal problem can be eliminated by exchange of Request to Send (RTS) signal from a sender (mark as A in Fig. 1) and Clear to Send (CTS) signal from a receiver (mark as B in Fig. 1). After receiving CTS from the receiving station, the transmitting station (node) sends the full information (data frame in packet or packets). At the transmission time of information indicated by RTS/CTS, all other nodes in the cell as well as the nodes lying outside the cell (like hidden terminal C in Cell-II shown in Fig. 1) are not transmit any information to the working nodes (A and B in Fig. 1) during further progress of the transmission packets (data), as a result the collision is avoided, as shown in Fig. 1.

If transmitting power of a node (vehicle) increases in a VANET, signal from the node spreads more area, i.e., the cell size becomes large, but throughput of the network, i.e., information handling capacity will decreases. One hop count is the minimum distance between one node to another neighborhood node. Again if the number of hops (nodes or cells) increases to set up a connection between the two nodes, expected path of life decreases. The transmission signal in a VANET is interference due to multipath fading, different type of noises, power supply fluctuation and out of cover range (mobility), etc. Therefore maximum care has to be taken to retrieve the signal in original form by eliminating noise using different antennas called diversity antennas and presently used MIMO (Multiple-Input-Multiple-Output) antennas, low noise amplifier (LNA) filter in the receiver circuit of the VANET node or vehicle. Also higher bandwidth (75 MHz) permits to use spread spectrum technique in VANET communications by adding number of extra bits in a frame or packet which ensures error free communication in real time basis. Therefore, VANET communication becomes more reliable and effective one for short range of ad hoc vehicle networks.
All vehicles (nodes) in a cell can be assigned station code or ID like Internet Protocol (IP) address and the packets (data) are routed to the ID address (node). This station code is liable to change very frequently as the vehicles are going inside or leaving outside the cell in a rapid manner. Since information (voice, message, data, image, etc.) are routed in the cell (network), any node within the cell can monitor or tamper the information. To avoid tampering or corrupting, certain encryption with authentication or security measures in the VANET communications are used. In this paper, we elaborately describe different routing protocols, i.e., how calls are routed or transferred from a calling vehicle (sender or source) to the called vehicle (receiver or destination) either directly or through different intermediate nodes (vehicles). At the same time we also propose Modified AODV (M-AODV) routing protocol in which artificial swarm (ant colonies) intelligence and optimization technique is applied.

III. ROUTING PROTOCOLS IN AD HOC NETWORK

In this section, we discuss the routing protocols available for ad hoc networks like MANETs and VANETs. Routing determines process of communicating information from one station to another station of the network through passing one or more intermediate stations, called intermediate nodes. An ad hoc routing protocol [3]-[15] is a procedure or standard, that controls how vehicles (nodes) decide which way to direct packets called traffic among nodes (computing devices) in a mobile ad hoc network. We survey the existing routing schemes giving special importance to popular routing techniques, that keeping in view of the information is allowed to move throughout the network. Absence of fixed infrastructure adopting, several types of challenges in routing for this kind of ad hoc networks are presented. Routing protocols of mobile ad hoc network require different approaches from existing Internet protocols (IPv4 or IPv6), since most of the Internet protocols are designed to support routing in a network with fixed structure. Lots of various routing protocols are coming to use. Proposed routing solutions for MANET and VANET are classified into seven types: proactive or table-driven, reactive or on-demand, hybrid, hierarchical, geographical, power-aware, geographical multicast protocols [4]-[15].

The routing protocols in ad hoc mobile networks like MANET or VANET are classified below by their properties.

A. Proactive or Table Driven Routing Protocol

Proactive protocol is one of the old ways of acquiring routing in mobile ad hoc networks [2]-[3], [7]-[15]. These protocols maintain consistent overview of the network. Each node uses routing tables predesigned to store the location information of other nodes in the network. This information is used to transfer data among various nodes of the network. Some of the common proactive protocols are like that Ad Hoc Wireless Distribution Service (AWDS) where layer two wireless mesh routing protocol used, Highly Dynamic Destination Sequenced Distance Vector routing protocol called DSDV, Babel routing protocol inspired by DSDV, Clusterhead Gateway Switch Routing protocol (CGSR), Direction Forward Routing protocol (DFR), Distributed Bellman-Ford Routing Protocol (DBF), Guesswork routing protocol, etc. Certain memory spaces in a node are always reserved for proactive routing techniques applied.

Table-driven protocols may not be considered as an effective routing solution for mobile ad hoc network. Nodes in mobile ad hoc networks operate with low battery power and with limited bandwidth. Presence of high mobility, large
routing tables, and low scalability result in consumption of bandwidth and battery life of the nodes. Excessive memory capacities are spending to store large routing table. Moreover continuous updates can create unnecessary network overhead. For this network jamming may occur due to this routing protocol.

B. Reactive or On-Demand Routing Protocol

This type of protocols finds a route on demand by flooding the network with route request packets. Actually, a route is decided on the availability of least distance, less overload or overhead, less consumption of electrical power, traffic solution, etc., and this protocol is changing in nature. It initiates a route discovery process, which goes from one node to the other until it reaches to the destination or an intermediate node which has a route to the destination. The main disadvantages of such algorithms are as followings:

i. High latency time in route finding.

ii. Excessive flooding can lead to network clogging, i.e., the network is blocked or congested.

iii. It is the responsibility of the route request receiver node to reply back to the source node about the possible route to the destination. The source node uses this route for data transmission to the destination node.

Some of the better known on-demand routing protocols are such as Robust Secure Routing Protocol (RSRP), Modified AODV (M-AODV), Multirate Ad Hoc On-demand Distance Vector (Mu-AODV), Reliable Ad Hoc On-demand Distance Vector (R-AODV), AODV-UCSB (University of California, Santa Barbara), AODV-UV (Uppsala University), Kernel-AODV, Minimum Exposed Path to the Attack (MEPA) in MANET, Ant-based Routing Algorithm for MANET, Admission Control enabled On-demand Routing (ACOR), Dynamic Source Routing (DSR) and Temporary Ordered Routing Algorithm (TORA), etc. Among these protocols, AODV routing protocol is more useful in ad hoc mobile networks. We are discussing the AODV protocol and modifying it as M-AODV for better performance in detail.

1) Features of Proposed Modified AODV Protocol

Ad hoc On-Demand Distance Vector (AODV) routing protocol [7]-[15] is more popular and effective one in ad hoc networks like MANET and VANET communications. It is jointly developed in Nokia Research Center, University of California, Santa Barbara and University of Cincinnati. Since AODV is a reactive protocol, it establishes a route to a destination only on demand. It is capable of both unicast and multicast routing. Complexity of a protocol is measured by lowering the number of messages to conserve the capacity of the network, from that point of view AODV assures no extra traffic for communications along the existing links.

AODV is invented from the Bellman-Ford distant vector algorithm. We adopt to modify this AODV protocol by artificial swarm (ant colonies) intelligence technique [15]. Swarm (ant) intelligence system is based on ant colonies. A colony of ants is able to find the best, i.e., the shortest path between their food source and nest by discharging chemicals, named pheromones. Pheromones are volatile in nature; all ants choose to move over tracks of high pheromone concentration. In the shortest path pheromone concentration is increased and the other ants are forced to choose this path. Likewise each vehicle’s (node’s) position is identified by its latitude indicated by North or South from the Equator and longitude indicated by East or West from the Prime Meridian which are obtained from Global Positioning System, i.e., GPS antenna system. This latitude, longitude, and the movement of a vehicle’s direction in form of destination sequence number are broadcasted to all other vehicles which are noted and updated in the look up table for routing purpose. All vehicles maintain a look up table in form of the destination sequence number (nearest node) in a particular direction and periodically (say 2~3 minute) refresh it. In case a vehicle wants to send information to another distant vehicle, first of all it collects the information about the location of the destination vehicle according to its destination sequence number. Then in that direction the shortest distance available vehicle within the source node’s power coverage zone is connected according to the look up table of destination sequence numbers, and further this process is going on till the terminal (destination) vehicle reached. This connection is set up through intermediate nodes and terminal node according to suggested Modified AODV (M-AODV) protocol.

Modified AODV (M-AODV) finds a route from a source to a destination only when the source node wants to send one or more packets (traffic) to that destination either through several intermediate nodes or directly according to the source node’s transmitting power coverage zone. The established routes are maintained as long as they are required by the source. It employs the destination sequence numbers to identify the most recent path. This destination sequence number is computed according to the nearest latitude, longitude, and direction of movement of the vehicle in Modified AODV protocol. Here swarm (ant colonies) intelligence technique [15] is applied through the latitude, the longitude, and the direction of movement of a vehicle which act as pheromone in ant colonies. A Route Request (RREQ) is flooded throughout the network and it contains the source address or identifier (SrcID), the source sequence number (SrcSeqNum), the destination address or identifier (DestID), the destination sequence number (DestSeqNum), the broadcast identifier (BeastID), and the time to live (TTL) field.

Destination sequence number (DestSeqNum) is determined in accordance with latitude, longitude (both in normalized form, i.e., divided by 360°), and direction of movement of the intermediate or the terminal destination nodes (vehicles) with respect to the source or the previous intermediate node. Hence, the equation is framed as below:
Destination sequence number (DestSeqNum) = \[w_1 \{\text{latitude of an intermediate or terminal node} - \text{latitude of a source or previous intermediate node}\} + w_2 \{\text{longitude of an intermediate or terminal node} - \text{longitude of a source or previous intermediate node}\}\] / 360° + w_3 \{\text{Manhattan Distance} \text{[Direction or coordinates of movement intermediate or terminal node} - \text{Direction or coordinates of movement source or previous intermediate node]}\} \quad \text{(1)}

If the latitude of a node is North, it has taken as it is, if it is South, then 180° is added to the South latitude or vice versa, and in case of the longitude of a node is East, taken as it is, if it is West, then 180° has to add for the West longitude or vice versa.

Here \(w_1, w_2, w_3\) are the respective weightages assigned to the latitude, the longitude, and the direction parameters. Generally \(w_1 = w_2\), and \(w_1 > w_3\). Also \(w_1 = w_2 = 1\) and \(w_3 = 0.5\) may be assigned. Direction of movement of the vehicle is mainly divided into eight regions and some specific coordinate values are assigned to each direction, such as,

- North \([N]\) = \((0,1)\)
- South \([S]\) = \((0,-1)\)
- East \([E]\) = \((1,0)\)
- West \([W]\) = \((-1,0)\)
- North-East \([NE]\) = \((1,1)\)
- North-West \([NW]\) = \((-1,1)\)
- South-East \([SE]\) = \((1,-1)\)
- South-West \([SW]\) = \((-1,-1)\)

Destination sequence number \(\text{DestSeqNum}\) is computed by this formula and it is dominated or accepted for less value.

The direction of movement of a vehicle is identified by the magnetic compass needle and transducer arrangement made for digitally transmitting purpose. The direction of movement of a vehicle with the latitude and the longitude are broadcasted for digitally transmitting purpose. The direction of movement may be fed automatically to all other vehicles, and noted in the look-up table of the respective vehicle. In two dimensions, the Manhattan Distance \([MD]\) between two points \(u\) and \(v\) having co-ordinates \(u(x_1, y_1)\) and \(v(x_2, y_2)\) is following:

\[MD(u,v) = |x_1 - x_2| + |y_1 - y_2|. \quad \text{(2)}\]

Instead of two dimensions if the points have \(n\)-dimensions \([16]\), the Manhattan Distance between two points \(p(x_1, x_2, \ldots, x_n)\) and \(q(y_1, y_2, \ldots, y_n)\) is:

\[MD(p,q) = \sum_{i=1}^{n} |x_i - y_i| \quad \text{(3)}\]

Therefore Manhattan distance between directions of movement of two vehicles for different directions from North \([N]\) direction are mentioned below:

- \([N-N]\) = \([0-0]+[1-1]\) = 0
- \([N-NE]\) = \([-0-1]+[1-1]\) = 1
- \([N-E]\) = \([-0-1]+[-1-0]\) = 2
- \([N-SE]\) = \([-0-1]+[1+1]\) = 3
- \([N-S]\) = \([-0-0]+[1+1]\) = 2
- \([N-SW]\) = \([0+1]+[1+1]\) = 3
- \([N-W]\) = \([0+1]+[1-0]\) = 2
- \([N-NW]\) = \([0+1]+[1-1]\) = 1

Similarly we can calculate the other Manhattan distances between any directions of movement of two vehicles. Therefore the least value of \(\text{DestSeqNum}\) is identified the unique routing information for this M-AODV technique.

The Broadcast identifier \((\text{BcastID})\) is incremented each time when the source node sends a new RREQ, so the pair \((\text{BcastID}, \text{SrcID})\) identifies a RREQ uniquely. If for the same destination RREQs are received multiple times by a node, the duplicate requests are discarded. When a RREQ is received by an intermediate node, if the intermediate node has either no route for the destination or no up-to-date route, the RREQ will be rebroadcasted with incremented hop count. If a node has a route with a destination sequence number lesser than or equal to that of RREQ, a Route Reply (RREP) message is generated and sent back to the source. Every RREQ carries a time to live (TTL) value which indicates that the number of times this message will be rebroadcasted. Every intermediate node, at the time of forwarding a RREQ, enters the previous node address and its BcastID. All intermediate nodes including the destination node having valid routes to the destination are allowed to send Route Reply (RREP) packets to the source.

After receiving a Route Reply (RREP) packet, the source node or intermediate node forwards the data packet to the next node towards the destination. If the source node later receives a RREQ consisting of either lesser sequence number or the same sequence number with a smaller hop count, it will update its routing information for that destination and starts using the better one. Data packets are buffered locally and transmitted in a FIFO queue when a route is set up. While a node in an active route gets lost, a Route Error (RERR) message is generated to notify the other nodes on both sides of the link about the loss of this link.

Since Modified AODV (M-AODV) is a reactive protocol, it uses periodic HELLO messages to inform the neighboring nodes that the link is still alive. The destination sequence number for each destination host is stored in the routing table of a node and it is updated in the routing table when the host computes lesser sequence number. This destination sequence number is calculated according to the latitude, the longitude, and the direction of movement of the vehicle. The direction of movement of the vehicle may be fed automatically by the vehicle operator or by the vehicle operator manually, because the vehicle operator also knows its destination position and physical route choice. If the direction of a vehicle is in the same direction for information exchange between the source node and the destination node, then the vehicle will persist long time to act as intermediate node. Generally a RREQ is initiated with a small TTL value; gradually it is increased to a certain threshold value for making more efficient route discovery process.

The main advantage of Modified AODV protocol is to create routing path on demand and that destination sequence numbers according to the latitude, the longitude, and the direction of movement of the vehicle which are applied for determining the least distance path (minimum hop count) to the destination. The connection set up time is lower; at the same time it does not require any central administrative system to control the routing process. Modified AODV reacts
fast to the topological changes in the network as it happens for MANET and VANET, and updates only the nodes are affected by these changes. The HELLO messages supporting the routes maintenance are range limited and easy to identify the faults appearing in the routes, so they do not cause unnecessary overhead in the network. Modified AODV also saves storage place, i.e., memory as well as energy or power and bandwidth. It is the best suited for a limited area ad hoc network, since the hop count remains confined within the certain range.

There are some disadvantages also in Modified AODV (M-AODV) protocol that determining a reasonable expiry time is difficult one, because the nodes are mobile in MANET and VANET. A route discovery may flood which causes significant network overhead. In larger networks, the nodes may be misbehaved like becoming malicious nodes by attacking the network or uncooperative (selfish) nodes. In AODV and Modified AODV it is assumed that all nodes are cooperative such that they help to create route and flow data through the established route as well as the vehicles supply authentic information for updating look up table in others.

The difference between Modified AODV and Dynamic Source Routing (DSR) is that DSR uses source routing in which a data packet carries the complete path to be traversed; hence DSR uses high power consumption, large bandwidth and network overloading. The Modified AODV protocol is loop free and avoids the counting to infinity problem by the use of sequence numbers. This protocol offers quick adaptation to mobile ad hoc networks with low processing and low bandwidth utilization.

Modified AODV protocol may be upgraded as quickest route discovery process by taking least information in Route Request (RREQ) packet which consists of source address or identifier (SsrcID), the destination sequence number (DestSeqNum), the broadcast identifier (BcastID), and the time to live (TTL) field. Furthermore TTL field value is optimized in accordance with the cell structure and average number of nodes lying in the cell.

C. Hybrid Routing Protocol

It combines both the proactive and the reactive approaches [3]-[15]. Zone routing protocol (ZRP) is a notable example. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. The choice for one or the other method requires predetermination for typical cases.

The main disadvantages of such algorithms are:

i. It depends on amount of nodes more to be activated.
ii. Reaction to traffic demand depends on gradient of traffic volume.

The following protocols are important in hybrid protocols that ARPAM is used specialized for aeronautical MANETs, Hybrid Routing Protocol for Large Scale Mobile Ad Hoc Networks with Mobile Backbones (HRPLS), Hazy Sighted Link State routing protocol (HLS) using a mathematical optimization to mix link state and reactive routing to optimize network data updates in space and time, Hybrid Wireless Mesh Protocol (HWMP) protocol for IEEE 802.11 is inspired by a combination of AODV and tree-based proactive routing, Order One Routing Protocol (OORP) in which proactive or reactive distance vector are combined with a hierarchy and that is not used to route data, Scalable Source Routing (SSR) uses routing messages along a virtual ring, Temporally Ordered Routing Algorithm (TORA) is used for routing data across Wireless Mesh Networks or Mobile Ad Hoc Networks, Zone Routing Protocol (ZRP), etc.

D. Hierarchical Routing Protocol

With this type of protocols, the choice of proactive and of reactive routing depends on the hierarchical level where a node resides. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding on the lower levels. The choice for one or the other method requires proper attribution for respective levels. The main disadvantages of such algorithms are followings:

i. It depends on depth of nesting and addressing scheme.

ii. Reaction to traffic demand depends on meshing parameters.

Examples of hierarchical routing algorithms are that Cluster Based Routing Protocol (CBRP), i.e., Core Extraction Distributed Ad Hoc Routing (CEDAR), Dynamic Address Routing (DART), Distributed Dynamic Routing protocol (DDR), Fisheye State Routing protocol (FSR), Global State Routing protocol (GSR), Hybrid Ad Hoc Routing Protocol (HARP), etc.

E. Geographical Routing Protocol

This protocol acknowledges the influence of physical distances and distribution of nodes to areas as significant to network performance. These functions are performed with the least amount of redundancy, by restricting flooding. The information contained in geocast packet header regarding the sender location and the zone of relevance or zone of forwarding is used in conjunction with the node’s current position to restrict flooding and reduce redundancy.

The main disadvantages of such algorithms are that:

i. Efficiency depends on balancing the geographic distribution versus occurrence of traffic.

ii. Any dependence of performance with traffic load discomforting the negligence of distance may occur in overload.

F. Power-Aware Routing Protocol

Energy is required to transmit a signal is approximately proportional to \( d^\alpha \), where \( d \) is the distance and \( \alpha \geq 2 \) is the attenuation factor or path loss exponent, which depends on the transmission medium. When \( \alpha = 2 \) (in the optimal case), transmitting a signal half the distance requires one fourth of
the energy and if there is a node in the middle willing spend another fourth of its energy for the second half, data would be transmitted for half of the energy than through a direct transmission, this fact follows directly from the inverse square law of Physics.

The main disadvantages of such algorithms are:

i. This method induces a delay for each transmission.
ii. No relevance for energy network powered transmission operated via sufficient repeater infrastructure.

G. Geographical Multicast Routing Protocol (Geocasting)

The zone of relevance (ZOR) is defined as the set of geographic criteria that a node must satisfy in order for the geocast message to be relevant to that node. This is similar to the “geocast region” or “multicast region”, except that additional criteria, e.g., the direction of node movement. It can be used to select among the nodes that are within a geographic area.

The geocast protocol has two main functions:

i. Forwarding the message through zone of forwarding towards zone of relevance and through zone of relevance such that the message travels towards the edges of zone of relevance, i.e., spreading the message in right directions.
ii. Delivering the message reliably to all the nodes within the zone of relevance.

The examples of geographical multicast protocols are that Location Based Multicast (LBM), Voronoi Diagram and Convex Hull Based Geocasting protocol, GeoGRID protocol, GeoTORA (Geographical TORA) protocol, Mesh-Based Geocast Routing protocol (MBGR), Mobile Just-in-time Multicasting protocol (MOBICAST), Abiding Geocast/Stored Geocast (Time Stable Geocasting) protocol.

IV. CONCLUSIONS

In this paper we have discussed Vehicular Ad Hoc Network working principles with different routing protocols, among which AODV and Modified AODV routing protocol is the simplest and highly useful one for ad hoc mobile network. The main feature of VANET is that a vehicle is very short time residing in a particular cell; self-organizing communication networks built up by moving vehicles. VANET are thus characterized by very high node mobility and limited degrees of freedom in the mobility patterns. In a VANET, the connected call is always making hand off or hand over from one cell to another cell with the help of various routing protocols as adopted.

Therefore, the stable connections are set up in a VANET communication by implementing fast and easy routing protocols like Modified AODV (M-AODV) in the VANET system. There are many variants of routing protocols for VANET transmission which have been proposed, those are basically the different forms of MANET routing protocols. Out of all such routing protocols, Modified AODV routing protocol based on artificial swarm (ant colonies) intelligence technique is the most suitable and realistic one with MANET and VANET characteristics within a real time basis.

REFERENCES

Authors Profile

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